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STRUCTURE

LIST OF TABLES

1. INTRODUCTION

As a developing non-oil producting country, Jordan is deeply effected by the world energy situation. Due to the continuing oil price increase and the ever increasing energy demand the Country's energy requirements are becoming a real burden on its national economy. In 1980 the cost of primary energy imported in the form of crude oil exceeded 11% of the G.N.P. (as compared to 1% only in 1970) and amounted to more than 100% of the total exports (as compared to 25% of the total exports in 1970). Table (1) shows the development of energy costs in Jordan through the past decade.

The average annual growth in primary energy demand over the last decade has been around 13%. However, the expected energy demand and the associated cost of energy over the coming ten years is even more alarming assuming that the same pattern of consumption will hold. For example the annual per capita energy consumption is expected to rise from 883 kg.o.e. (kilogram of oil equivalent) to reach 1350 kg.o.e. by 1990 with a total consumption figure of 4 million tons of crude oil. If Jordan to continue to be 100% dependent on oil for its energy needs its energy bill is expected to top the 10,000 million U.S. Dollars for the period 1980-1990. By that time the Nation's energy bill is expected to swollow almost 20% of its G.N.P.

The government of Jordan is fully aware of the critical energy situation in the country and efforts are gathering momentum to introduce a number of radical measures on the organizational level and major projects with the objective of:

- reducing the country energy dependence
- reducing the imported oil bill through the development of local resources

This paper which is prepared for the United Nations Conference of Nairobi on the new and renewable resources of energy is intended to give a general survey of the energy situation in Jordan and illustrate the current and planned activities in the field of new and renewable energy resources.

Although the very nature of the means in Jordan assume a number of constraints on the energy activities in the country yet all efforts are directed towards expanding these means through regional and international cooperation.

Table (1)

Development of Energy
Costs in Jordan (1970-1980)

Year	Import of Crude Oil	Cost of Energy / Cross National Income (%)	Cost of Energy/Export (%)
1970	6	1	---
1971	9	1	---
1972	11	1	31
1973	24	2.8	56
1974	50	5.8	49
1975	76	6.1	61
1976	92	5.1	62
1977	113	5.8	62
1978	129	5.7	69
1979	190	7.3	86
1980	360	11	100

2. THE CURRENT ENERGY SITUATION

2.1 Structure of Energy Supply:

Due to the fact that Jordan has no indigenous source of energy investable on commercial scale up till now all energy supplies are imported.

Non commercial energy supplies are very limited and they play a decreasing and insignificant role in the national energy package. On the otherhand the government is disencouraging non-commercial energy fuel since it is almost wood fuel and charcoal due to the deforestation effect it is inflicting on the country side.

The present era of socio-economic development in Jordan started in the early fifties, and flourished in the past 30 years i.e. during cheap oil era hence the energy imports were directed towards oil.

The energy supplies structure for the year 1980 is as follows:

Imported oil 99.5%
non-commercial fuel: 0.5%
- wood fuel
- dung

Oil is imported from neighbouring Saudi Arabia via Tapline a pipeline which extends from the eastern coast of Saudi Arabia up to the Lebanese port of Sidon on the Mediterranean. The Crude is fed to the only refinery in the country via a bypass. The local demand for the refined products is totally satisfied by the refinery which has a current capacity of 12000 ton/day. This refining capacity is expected to meet the country's needs for oil derivatives until the turn of the decade provided that no unexpected jumps in present curve of growth rate develops in the future, a phenomenon which is to be rather expected in developing economics. Table (2) illustrates the development of crude oil imports during the period 1970 - 1980, while table (3) gives the development of the refining capacity in the oil refinery.

2.2 Structure of Energy Demand:

The structure of energy demand has developed in conjuction with available supplies. Hence all industries that require primary energy supplies had to be oil oriented since no coal or gas quantities can be obtained. Small industries have to use electricity or oil derivatives. The structure of demand for the year 1980 was as follows:

1.	Primary Energy Crude oil, derivatives, etc...	75.5%
2.	Electricity Central and private generation	24.5%

Table (2)

Energy in Jordan
Development of Energy Consumption

Year	*Energy Consumption m.t.o.e	Annual growth %	Energy /Capita** (Kgo.e)
1970	0.45	----	286
1971	0.53	17.8	331
1972	0:60	17.2	355
1973	0.67	11.7	383
1974	0.74	10.4	386
1975	0.84	13.5	524
1976	1.09	29.8	514
1977	1.22	11.9	553
1978	1.39	13.9	630
1979	1.60	15.0	730
1980	1.84	15	855

* m.t.o.e = Million ton of oil equivalent

** Kg.o.e = Kilogram of oil equivalent

Table (3)

Development of Oil
Refining Capacity in Jordan

Year	Refining Capacity Ton / Day
1960	1000
1970	2120
1975-1979	4900
1980-1995	12300

3. PRESENT PATTERN OF ENERGY CONSUMPTION

3.1 Consumption of Oil Products:

Total primary energy consumption amounted by the end of 1980 to more than 1.8 m.t.o.e. indicating a growth rate of 15% over the year 1979. This remarkably high rate reflects the speed at which the Jordanian economy is developing. The year 1980 was not exceptional, the average growth rate over the past decade was more than 15%. Yet it must be very clear that the energy share percapita in Jordan which was 855 kg.o.e. in 1980 is still quite modest and very much below the level of developed countries (see table (2) for details).

There were no signs that this rate of growth will be damped during the present decade unless a comprehensive energy conservation policy is adopted in conjuction with a more effective pricing policy and the introduction of new and renewable energy resources.

A shift in investment policy from energy-intensive to less energy-intensive industries will help to damp the growth rate as well.

The consumption of oil products shows that there is an increasing demand for light distillates in the same manner as for heavy ones. Table (4) shows the development of consumption of commercial oil products for the period 1970-1980.

3.2 Sectorial Distribution of Consumption:

The major sectors of the Jordanian energy consumption machine are:

Transportation
Electricity
Industry
Domestic

Other sectors such as agriculture, services or commercial activities are of small value.

Transportation in Jordan is the dominant energy consumer where 50% of the energy package is used for transportation with 36% for road transportation and 14% for air transportation. This imbalance can be attributed in the fact that transportation is still working on individual and small size system with the lack of rail transportation.

Domestic usage of energy amounts to about 2% of both primary energy and electricity. The dependance on oil products for domestic purposes is quite evident. Table (5) details the sectorial energy distribution of the year 1979 a pattern with persisted for the year 1980.

3.3 Consumption of Electricity:

Electricity generation consumed some 16.7% of the country's oil input in 1980. It is expected however, that electricity will increase its share of oil consumption to 18% by 1981 to reach 27% of the total consumption by the year 1980. This intensification of electricity is due to the fact that there is a suppressed demand that could not have been met in the past. Expansion of nation wide rural electrification schemes, expansion of industries and services in additional to natural growth all contribute the increasing share of electricity.

The installed capacity in Jordan amounted to 300 MW in 1980 and expected to reach 600 MW by the turn of the century. Tables (6), (7) and (8) give the detailed figures of electrical energy in Jordan.

Table (4)

DEVELOPMENT OF COMMERCIAL FUEL CONSUMPTION BY PRODUCT
(1000 Ton)

Product	Year						
	1974	1975	1976	1977	1978	1979	1980
Crude Oil	751	828	1 145	1 145	1 396	1 612	1 763
L.P.G.	24	29	37	36	43	45	53
Gasoline	136	159	203	211	248	274	317
Avtag	10	15	11	18	17	16	22
Avtur	50	58	88	109	127	172	176
Kerosine	109	113	160	107	148	153	167
Diesel	195	227	336	350	417	469	520
Fuel Oil	189	193	240	234	291	388	397
Asphalt	37	35	64	82	106	90	106
White Naphtha	0.3	--	0.5	0.3	0.4	0.5	0.5
Total	750.3	829	1139.5	1147.3	1397.4	1607.5	1758.5

Table (5)

Sectorial Energy Consumption
(1979)

Sector	Energy Consumed m.t.o.e.	% of Total
Transport	778153	50
Domestic	227727	15
Electrical Generation	218432	14
Industry	234194	15
Agriculture	3260	2
Others	95908	6
Total	1557674	100

Table (6)

Population & Electricity

Year	Number Of Population in(1000)	Percentage of Population Supplied by Electricity	Energy Generated (G.W.H.)	Average KWH consumed per capita (KWH)
1971	1 723	32%	230	133
1972	1 774	33%	278	157
1973	1 831	35%	315	172
1974	1 890	37%	350	185
1975	1 952	39%	407	209
1976	2 037	40%	503	247
1977	2 126	43%	595	280
1978	2 217*	45%	703	317
1980	2 152**	55%	877	408

* Estimated

** Actual (Census 1979)

Table (7)

Development of Consumers (1000)

Year	Amman & Balqa	Irbid	Karak	Ma'an	Total
1971	61	19	3.0	3.7	87
1972	67	23	3.6	4.1	98
1973	82	25	4.1	4.4	116
1974	88	27	4.6	4.5	124
1975	95	31	4.7	5.1	136
1976	103	35	5.1	5.2	148
1977	111	40	5.4	5.7	162
1978	125	43	5.9	6.4	180
1979	149	50	9.3	7.6	216

Table (8)

Rural Electrification

Year	Rural Population (in 000)	Rural Population Supplied by Electricity (in 000)	Percentage Supplied by Electricity %
1974	738	120	16
1975	766	132	17
1976	795	212	27
1977	827	246	30
1978	860*	331	38
1979	882**	347	39

* (Estimated)
** Actual (Census 1979)

Rural electrification programmes are receiving serious attention in Jordan.

Due to intensive efforts over the previous years, some 40% of the rural population are now supplied with electric power against 92% of town and city dwellers. It is expected that this percentage will double to reach 80% on the completion of present and future planned programmes over the next seven years.

Rural electrification plans are aimed at increasing the number of electrified villages within a short period from 131 to 380 over a three year period. By 1992 all villages in Jordan will be connected to the National Grid. Table (9) gives characteristic figures concerning electrical generation and distribution.

When examining the development of demand for electricity one can see that consumption increased at an average annual rate of about 19% between 1975 and 1979, increasing from 355. GWH in 1975 to about 723 in 1979.

Peak load increased form 88 MW in 1975 to 188 MW in 1979 representing an average annual rate of growth of about 21%. Table (10) shows sectorial consumption of electrical energy in Jordan

Table (9)

Electrical Generation
Characteristic Figures For 1980

Generation	All Jordan 1980	All Jordan 1979	Interconnected 1980	Interconnected 1979 %	System Growth
Peak Load (MW)	196	183	163.6	153	6.9
Generated Energy (GWH)					
Steam Units	608	478	589	460	28
Gas Units	74	72	74	72	2.7
Diesel Units	588	230	148	118	25.1
Total Gen. Energy	1070	877*	811	650	24.7
Total Sold Energy	877	723	747	604	23.7
Loss Percentage (%)	18.04	18.3	7.97x	7.02x	
Generation Fuel Consumption (1000X Ton)					
Diesel	70	76	34	35	2.9
Heavy Fuel	233	175	209	162	29
Total Fuel Consumed	303	251	243	197	23.4
Generation Thermal Efficiency %	31	30.8	29.4	29.1	
Average KWH Consumed Per Capita	482	408			
No. of Consumers(thousands)	236	216			
Population Under supply (thousands)	1417	1298			
Percentage of Population Under Supply	64%	60%			

X Not including Loss of Energy in Dist. Networks

* Not including Purchased Energy From Syria (8GWH).

Table (10)

Sectorial Consumption of Electrical Energy
(1980)

Sector	Total Consumed	% of Total
Domestic	321	36.6
Industrial	306	34.8
Commercial	107	12.2
Sewage & Water Pumping	76	8.7
Hospitals & Charities	40	4.6
Street Lighting	16	1.8
BroadCasting & TV	7	0.8
Others	4	0.5

4. NEW ENERGY RESOURCES IN JORDAN

Jordan is one of the few countries in the Arab World where conventional primary sources, starting from oil and ending with hydroelectric potentials are quite scarce.

Yet one should admitt that the efforts and investment allocated for oil exploration for example in the past 20 years were not intensive enough due to technical as well as economical reasons. Because of the continuing energy demand growth and the burden, such a growth imposes on our economy, there is an urgent need in the country today to develop the sources of energy which are indigenous to the country.

A part from oil possibilities Jordan has a number of new energy potential resources which could act as an energy base in the next decade and later. The question of technology and finance which such sources require to develop are quite formidable. Table (11) summaries the potential energy resources in the country.

4.1 Oil Exploration:

The first reports on the possibility of oil being found in Jordan were published in the year 1947. Between the years 1954 and 1973 seven foreign firms obtained concessions for exploration but only four performed field operations over a period of about nine years. During this period 13 deep-exploratory wells were drilled, but only traces of oil were found in two prospect areas. The National Resources Authority (NRA) signed an agreement in 1975 with a U.S. Firm for oil and gas exploration within an area of 8400 km^2. The Firm carried out several geological and geophysical studies the results of which were not encouraging.

Several new studies were carried out between the years 1975 and 1978. Due to the lack of financing and interest shown by the international oil firms the oil exploration work in Jordan is still limited. At present no one company holds exploration concessions in Jordan. NRA is planning to sell the results of its independent seismic for review and bidding any talks with oil companies regarding the oil exploration will be under production sharing type of agreement.

Table (11)

Potential Primary Energy Resources

	Source			
1.	Oil Shale	Geological reserve	30000	m.t
		proved reserve	1200	m.t
		Area of proved reserve (Lajjoun only)	26	Km2
2.	Uranium	Phosphate reserve	100 000 000 t.	
		Uranium to phosphate ratio	80-160/1 000 000	
		Uranium reserve	8000 - 16 000 t.	
3.	Solar	Average Sunny hours/year	3 300	
		Max. KWH/m2/hr	6 75	
		Efficiency-	theoritical	22%
			practical	12%
4.	Hydropower			
	a - Al Mukaran Dam	43-50	GWH/annum	
	b - Talal	3.5-4	GWH/annum	
	c - Red Sea Dead Sea Hydro Link	360	GWH/annum	
5.	Petroleum	Under exploration		
6.	Gas	Under exploration		
7.	Tar Sand	Exists in moderate quantities		

4.2 Oil Shale:

4.2.1 General:

Oil shales as it is well known are fine, grained sedimentary rocks containing solid organic matter which, on heating disintegrate into oil and gas, but which do not contain any free oil. The liquid fractions resulting from heating shale resemble crude oil and can be refined to yield conventional petroleum products. Such as gasoline, diesel oil and fuel oil. At higher temperatures more light products and also more gas are formed.

The direct burning of crushed shales as a low grade "coal equivalent" has been known for several decades and it is still used in U.S.S.R and few other countries. It is mainly used for power generation by means of specially designed boilers.

4.2.2 Oil Shale in Jordan:

The oil shale in Jordan are known to exist in large quantities in the three major areas: north middle and south. The largest deposits are at El-Lajjoun about 100 km south of Amman. The Geological oil shale reserves are estimated at 30 billion metric tons which are mainly lying in the northern and central parts of the country.

The total proven reserves of the El-Lajjoun oil shale deposite amount to 1.2 billion tons of bituminous marl with an oil content of 115.5 million tons.

In order to have a reliable and up to date quantitative and qualatitative evaluation of El-Lajjoun deposit; Technopromexport of the USSR and Klocknet-Lurgi group of west

Germany are currently conducting a technical and economic feasibility studies for the utilization of oil shale in Jordan along two lines:

1. The direct combustion process for generating (300 - 400) MW of electricity
2. Retorting of the shales for production of 50,000 barrels of shale oil per day.

The results of these studies which are considered complementary to one another are expected to be available within 12 months today. Based on the results a full pledged feasibility study will follow. However, the making actual use of shale oil in Jordan is not expected before the turn of the decade.

It is worthmentioning here that Jordan is trying to establish two-way links of cooperation with countries having experience in this field such as Morroc.

4.2.3 Technology, Economics and Politics:

The cheap-oil era did not help the technology of oil extraction from shales to develop in propertion to it is potential role as a fossil fuel carrier. A part from extraction technology shale oils do not require any major changes or modifications in the consuming system, a very attractive merit that many of new energy resources do not enjoy.

Three major technological as well as ecological problems have to be solved before shale oil can take a good share of the world energy supply problem.

1. Rising the efficiency for (as a percentage of fuel content) of extraction at reasonable costs and by reasonably available techniques.

2. Solving the ecological problems emerging from the huge amounts of ashes.

3. Minimizing the water requirements for the whole process.

Due to the fact that oil shale is part of the oil industry in the general sense hence its economics are quite relative in the commercial and political sense.

Oil shale exactly like oil was and still subject to oil companies views and interests regarding commerciability. The huge funds and complexed know-how envolved, make it difficult to any developing country to test the credibility of oil companies "estimates" regarding the costs of oil if it is to be extracted from shale. One can notice with or without suprise that although oil shale is not in the market yet the "estimates" go up parallel to the oil prices as shown in table (12).

As for Jordan the economics of shale oil production is still not determined yet awaiting the results of some technical studies. It is useful for sake of illustration to give here a rough picture of the possible economics of shale in Jordan in the form of a hypothetical case study:

1. Required crude shale oil for 3000 megawatt plant : about 345,200 tons per year, or 2,325,000 barrels per year

Thermal efficiency, annual average load factor, and annual operating days are supposed to be 37 percent, 65 percent, and 330 days, respectively.

Gravity of the crude shale is supposed to be 20°API, or 0.934 specific gravity.

2. Required oil shale mining : about 3,836,000 tons per year

Crude shale oil content is supposed to be 9 weight percent.

3. Required oil shale retorting plant capacity : about 12,000 tons per stream day

Annual operating days is supposed to be 330 days.

Investment cost and production cost as of 1980 for 345,000 tons per year of crude shale oil production plant have been roughly estimated in the followings:

4. Estimated total investment cost : 226.2 million US$

	million US $
1. Mining, Crushing & Spent Shale disposal (Mining Capacity: 4,000,000 tons per year)	22.8
2. Retorting Plant (Capacity: 12,000 tons per stream day)	101.3
3. By-Product Recovery	22.5
4. Utility & Auxiliary Facility	45.0
Sub Total	191.6
5. Interest During Construction (Dept: 70%, Interest: 10%/yr)	20.6
6. Start-Up Expense (5% on Sub Total)	9.6
7. Working Capital	4.4
Total	226.2

5. Estimated crude shale oil production cost : 33.9 $/bbl, or 228.6 $/ton

	Million US$ Per Year	$/barrel
1. Direct operating cost	23.4	10.0^{6}
2. Depreciation*1	22.2	9.5^{5}
3. Profit before tax*2	33.3	14.3^{2}
	78.9	33.9^{3}

*1: Depreciable capital investment cost and depreciation period are 221.8 million US$, 10 years, respectively.

*2: 15% on depreciable capital investment cost.

Table (12)

Development of Cost
Estimates of Shale-Extracted Oil

		1960	1973	1974	1975	1979	1980
Oil	% Barrel	1.95	2.41	10.95	10.46	17	24
	% Barrel	----	23.5	354.37	4.47	62.5	42
Shale Oil	% Barrel	3	5.5	6.9	13	22-25	40-50
	% Rise	----	67	50	73	81	91
Shale Oil/ Oil	(%)	153.8	207	68	124	138	187.2

4.3 Tar Sands:

Tar sands are an extreme case of heavy oil occurance. They consist of sand or sandstone. Impregnated with a heavy viscous asphaltic oil and are usually exposed at the earth's surface or covered by only a thin overburden.

Due to technical difficulties, methods of treatment of such sands are still rather costly. Known methods for obtaining oil do not yield more than 5% of the oil available in the sand. Efforts should be continued to improve methods of sand treatment. Many arguments regarding the actual commerciability of shale oil do apply for oil sands.

In Jordan, tar sand was found to occur in Wadi Isal located on the eastern side of the Dead Sea. All far sand occurances in Jordan todate are considered to be very limited and their commercial value has to be investigated through a well defined and financed programme.

4.4 Radioactive Minerals:

Exploration for radioactive minerals in Jordan started in 1973. Radiometric survey by hand and carbone scintillometer supplemented with gamma ray legging of boreholes have covered a large area in Central Jordan. The important anomalies existed in the outcrops of phosphorites and in the areas where the phosphate is covered by this allovium.

A comprehensive exploration programme was commenced in the fall of 1979 where an airborne spectroradiometric survey was conducted for the whole country. Occurences of natural radioactive minerals in the surficial deposits were delineated. The survey shows more radioactive anomalies of uranium sources in the phosphorite and therium anomalies in the paleozoic sandstones.

4.4.1 Uranium:

The aeroradiometric map of the country shows a large area of uranium anomaly coinciding with the phosphorite distribution. The anomalous areas include also the overlying Chalk-Marl Unit which is partly phosphatic and contain huge quantities of oilshales which is slightly radioactive.

Other surficial occurrences of uranium have detected by scintillometry in the recent but springs area of Zarqa, Ma'an and Zara on the eastern side of the Dead Sea and in Mukheiba hot springs area in the southeastern side of Yarmouk River.

Uranium minerals, autunite, tayamunite and possibly others are disseminated in the phosphorite section. Their concentrations show generally a decrease from north to south within the phosphorite unit. The concentration of Uranium in the upper phosphorite unit increase with an increase of $P_2 O_5$ percentage.

The uranium content ($U_3 O_8$) in the phosphorite section ranges from 24 ppm to 204 ppm.

Reserves of uranium ($U_3 O_8$) are estimated to be five million metric tons. Only about 200 thousand tons of this amount are contained in the minable phosphate beds.

4.4.2 Thorium:

Thorium has been discovered in the Paleozoic sandstones in the southeastern desert. Anomalous area is covered by Ordovician and lower Silurian sandstones and sandly shales. The strongest therium anomaly is found in the Graptolite Sandstone Unit.

The semi-quantitative spectrographic analysis gave high values of zirconium (Zr 300 ppm), strontium (200 ppm), barium (200-700 ppm) and rare earths (La, Y. Nb, to 500 ppm), tungesten (300-1000 ppm), Litanium (0.2-0.7%). The gamma ray spectrometry indicates about 400 ppm of thorium oxides in these deposits. Thorium is possibly contained in the zircon, monozite minerals in this unit.

4.4.3 Radium:

Radium has been detected in one location near the Rift Valley by gamma ray spectrography using a semi-conductor device. The radium occurs in a recent hot spring deposit which is composed of a dark earthy unconsolidated material that is rich in manganesium and iron and contain calcium and magnesium carbonate.

The strong radiation of this deposit is due to radium (226) which is a disintegration product of uranium. The radium in that location is supposed to have been derived from a deeper uranium source reached by hot circulating groundwater that preferentially dissolved radium compounds which is then deposited on the surface when thermal water cooled down and chemically changed.

Jordan Fertilizer Industry Co. Ltd. has been investigating the possibility of extracting the uranium from the high grade phosphate (TCP 73-75%). If the investigations come up with positive results, an amount of 80-100 tons of U_3O_8 (yellow cake) per year might be produced from 1.3 million tons of phosphate.

5. RENEWABLE ENERGY SOURCES

5.1 Geothermal Energy:

Jordan has limited Geothermal resources which exist in the form of hot springs in two major areas. The surface temperatures of the two areas are 45°C and 63°C and the combined discharge of these two springs into the Dead Sea is approximatly 2,000 m^3 per hour. Some further geophysical and geochemical studies are still necessary before a decision of utilization can be taken.

5.2 Hydropower:

The lack of water resources in Jordan, scarcity of rivers or water falls made the hydropower potential with the exception of Red Sea - Dead Sea hydro link quite modest, and amounts to about 50 GWH per annum or the equivalent of 15000 ton of fuel oil in a conventional steam power station. Yet the Jordan government is looking seriously to the development of the hydropower potential of the country as part of inhansing the degree of energy dependence in addition to the obvious economical return.

5.2.1 King Talal Dam:

This is a small dam on Zarqa River. The dam is already built and studies are now going on to introduce some structural and hydro-modifications including the construction of a small hydropower plant of 2 MW capacity designed for 6 hours a day during the peak period. The estimated costs of the power plant are about 8 million U.S. Dollars.

5.2.2 Makaren Dam:

Makaren Dam falls on the Yarmouk River in the northern part of Jordan. The available head is expected to be in the range of 200 m., and the hydropower plant shall be 2 km off the dam body.

Feasibility studies for the project are completed. The power house shall comprise 2 units of 10 MW each producing about 50 GWH per annum.

The powerstation will be connected to the national grid via a 31-km 132-kv single circuit transmission line. The estimated costs of the power system shall be 15 million U.S. Dollars, while the estimated cost of the dam itself is 500 million Dollars including the irrigation system and water canals.

5.2.3 Red Sea - Dead Sea Link:

The general outlines of the project which is underconsideration now is connecting the Red Sea with the Dead Sea through a system of open and closed hydrolinks making use of the head difference between the two which is about 400 meters to generate electricity:

1. Red Sea water has first to be pumped up from Aqaba to Gharndal 85 km north of Aqaba via a system of reseviours and then down to the Dead Sea by gravity via 4 hydropower plants.

2. Power generation capacity shall be 334 MW for 8 hours with a total net energy generation of 350 GWH.

3. The project is feasible to start in the eighties with a total estimated cost of 850 million dollars.

It is worthwhile to mention here that the power output can be extended depending on the final level of the Dead Sea. The figures attached show the proposed layout of the project.

5.3 Solar Energy:

5.3.1 General:

Jordan is blessed with a good solar energy resource. The average daily radiation is about 5 Kwh/m^2 and the sun shine duration is about 3000 hours per year. With increasing burden of the cost of energy on Jordan's economy a move was taken since 1972 to harness Jordan's major indigenous source of energy that is solar energy. R & D activities in this field are currently carried out at the Royal Scientific Society (RSS) with the following objectives:

1. To develop, adapt and transfer solar and wind energy technology to Jordan.

2. To conduct research and development activities and to test pilot plants with the objectives of introducing and promoting the use of solar and wind energy in the country.

3. To establish local scientific and technological base in this field.

4. To advise the private and public sector's on standards, production methods and quality control of equipment utilizing solar and wind energy.

5.3.2 Applications of Solar Energy in Jordan:

1. Domestic Solar Water Heaters:

The solar water heaters utilization for domestic use has increased in Jordan. This increase is indicated by the growth of the domestic solar water heaters industry. The number of the solar water heaters workshops increased from 1 in 1976 to about 20 in 1980. The industry is currently working with a capital of 2 million dollars, employing 102 technicians with a capacity of 85 units per day.

2. Agricultural Green Houses:

Jordan's utilization of solar energy for agricultural applications started in late 1970. The area cultivated in green houses in Jordan increased from 50 Acres in 1970 to 1500 Acres in 1980. Two local manufactures are currently producing the plastic covers needed for agricultural green houses with a capacity sufficient for local use.

3. Radio Telephone System Powered by Photovoltaic Cells:

Jordan has installed 88 units of such a system in rural and remote desert locations. These units were acquired by direct purchase from the USA. Additional units are required to satisfy the great number of villages and long desert roads in Jordan. The system is providing an efficient, reliable and cheap method of communication.

4. Solar Evaporation Ponds for Potash Recovery:

The Jordanian Potash project is utilizing both the brine reserves of the Dead Sea and the solar energy to recover about 1.2 million tons per year of potash and other by-products. Three evaporation plans have been constructed with a total area of 76 km^2. The Dead Sea water is pumped into these ponds where the brine concentration and precipitation of salts take place. The total solar energy utilized in this process is estimated to be 3.21×10^{13} Kcal per year. This energy is equivalent to the energy available in 3.25 million tons of crude petroleum costing 749.1 million U.S. Dollars.

The RSS is having a 5-year R & D plan in solar energy with the following outlines:

a. Feasibility of Renewable Energy Application

b. Technical and Economical Feasibility Studies for Solar Water Heaters Industrialization.

c. Water Pumping Using Photovoltaic Cells.

d. Water Pumping Using Wind Energy.

e. Electrical Power Generation Using Photovoltaic Cells.

f. Solar Thermal Power Generation.

g. Power Generation Using Solar Ponds.

h. Solar Cooling.

i. Solar Energy for Agricultural Purposes.

6. POLICY CONSIDERATIONS IN NEW AND RENEWABLE ENERGY RESOURCES (NRER)

6.1 General:

The rise in oil prices as well as the inivitable depletion of traditional fossil sources created the necessity of working out means for exploiting renewable sources of energy such as solar energy, wind energy, tidal, wave power, biofuels water power, geothermal energy, etc...

Although the technology of NRER on commercial scales still under progressing development such sources of energy will definitely play a major role in the future.

Under certain conditions developing countries may develop their potentialities to enter the age of NRER on limited scale before or at the same time as the industrial countries.

One can state with much data to support the argument that one of the major factors that slow down the development of NRER technology and application in developed countries is the very huge investments already committed to traditional energy sources coupled to the very heavy inertia of energy consumption dynamics. Changes of mode and pattern of systems in developed countries cannot be but gradual and to cost-benefit criterion. In developing countries the situation is almost different.

Their population tend to be less concentrated as to make decentralized use of energy centres possible. More than 50% of the population of Latin America, 70% of the population of South Asia 85% of the population of Africa live in the country-side.

Unfortunately the state of art of NRER assumes a direct and heavy responsibility in R & D on behalf of the developing countries. Being very modest in its economical resources the financing of R & D becomes a problem by itself. However, the scaring energy bill may justify spending money in this direction.

It is beleived that unless R & D efforts are made on collective basis for gathering regional or sub-regional organizations, no real progress can be achieved. Incidentally the political formation of a number of developing countris make techno-economical integration with neighbouring countries almost a must for survival.

More over it is to be emphasized here that effective science and technology policy for the development of renewable energy in developing countries cannot be made in the absence of or in isolation from a general science and technology policy for development. In addition, proper planning for the development renewable energy cannot be made in the absence of or in isolation from general energy planning that takes all energy sources into consideration.

6.2 Energy Planning:

Energy now ranks equally in importance with the classical factors not only of production i.e. land, labor and capital, but with those survival in the sense of modern civilization. Short, medium and long-term planning for renewable energy is indeed complex. This is due to the complexity of energy planning as whole, which is intrinsically linked to social and economic planning in a geo-political frame. The identification of long-term energy needs also requires the ability for long-term social and economic planning. This is in most cases of developing countries is over complicated by the lack of detailed knowledge of the possible role of renewable and other sources of energy in the complex internal and external social and economic development processes. Hence, clear-cut solutions for each country cannot be readily make; extensive research is greatly needed in this area. Two broad approaches to energe planning can be adopted. The first is the energy system approach, which deals with three major and dynamically linked activities:

1. Increased production of national resources
2. More efficient conversion processes
3. More developed national conservation programme

The second approach assumes:

1. Development solutions
2. Changes in development strategy

R & D has to play a vital role in the development of planning abilities and techniques and in implementation of renewable energy sources regardless of the planning approach which is adopted.

The absence of proper energy plans in many developing countries is mostly due to the absence of appropriate energy institutions and to the shortage of competent energy planners within the frame work of the decision making appratus. The developmetn of the capacity for energy assessment and energy planning for all sectors of the economy should take a high priority in the science and technology as well as administration plans for each country. The development of such a capacity can also be enhanced through regional and international institutions to be established for this purpose.

6.3 Energy Policy in Jordan:

Like most developing countries Jordan rather recently started to give an increasing attention to the question of energy in the four known directions i.e.:

1. Energy Supplies
2. Development of Local Resources
3. Research & Development
4. Organizational Structure

6.3.1 Energy Supplies:

The increasing demand for primary energy supplies makes the availability of such supplies a very vital question. At the moment Jordan is using oil from one supplier at one supply point.

A programme for diversification of fuel and supply point is under consideration.

The five-year plan for the period 1981-1985 has in its provisions the expansion of the oil national pipeline network as well as the possibility of building an oil refinery in the southern tip of the country in Aqaba on the Red Sea.

6.3.2 Development of Local Resources:

Oil and Gas exploration are receiving great attention in the coming five-year plan with purpose of having a local energy resource. Encouragement is given to all interested exploration companies to work in Jordan in addition to building the local capability for such operations.

In addition to shale oil which is now understudy from both a German consortuim as well as a Soviet enterprise the development of solar energy as a local sources in highly encouraged little work has been done on wind or other renewable sources of energy but it is hoped that a comprehensive development programme will be worked out to cover all potential energy sources in the country.

In many cases lack of funds for research or development acts as a difficult barrier to overcome, yet Jordan is investing reasonably in training local personnel in different fields of energy technology.

6.3.3 Research and Development:

The Royal Scientific Society (RSS) is taking the major share in research and development of new and renewable energy resources. A five-year research programme was prepared and the programme is based on the following:

1. Development of additional energy resources (solar, biogas, wind, etc...)

2. Development of a more efficient and sensible energy end user.

3. Development of better energy devices and systems.

However, it is relevant to emphasize here that the concept of R & D in this field is a practical one i.e.:

a. To have a direct application of the developed device

b. To offer technological services to the energy consuming public.

6.3.4 Organization Structure:

At present the organization structure of the energy sector is rather scattered, it belongs to the cheap oil era. There are about 12 bodies handling the energy question in one way or another. The government is realizing the importance of having a central energy planning and policy making body. This new body will act as a national umbrella to the specialized institutions without eliminating or diminishing their role. The national five-year plan called for the establishing of General Energy Corporation.

7. COOPERATION BETWEEN DEVELOPING COUNTRIES

The very fast growth in demand for almost every type of commodity coupled to the population high rate of growth drive the developing countries to have their future (in the economical-potential sence) decided by the very complexed output of the three major issues: Technology, Energy and Food, or: Technology-Energy- Food Triangle, or TEFT.

Most of the developing countries have their TEFT outside their control and has little indigenous roots.

Unfortunately the complexities involved are beyond the capability of most developing countries in their individual capacity. It is obvious that energy technology requires on behalf of developing countries concentrated efforts based on well planned choices. At the same time, energy choices which developing countries have to make are complicated.

The limited financial resources, lack of suitable energy reserves and etc..., all limit the range of choice.

Because technology as a socio-environmental-economical phenomenon has a very distinct regional nature the solution of any TEFT problem cannot be but on regional bases. Developing countries have to face the fact that without energy regional grouping the chance for any single country to break through is very slim:

- Funds for research and development of sources.
- Technical personnel.
- Economic scales.
- Market integration.
- Transportation.
- Information and scientific data.
- Counteracting political and economical pressures.
- Regional and local price control.
- Processing and marketing of raw materials.
- Strategic reserves of energy resources and food.

All those elements make regional energy grouping is a pre-requisite for any future development that may guarantee minimum degree of security in energy and otherwise.

No one researcher or a single group of researchers can decide for the developing countries what energy or technology choices they have to adopt. The choice can develop collectively through joint work and planning. The energy R & D (or the TEFT general) is becoming too costly on behalf of the developing countries to be handled without proper institutionlization locally sub-regionally and regionally.

Although it may be recognized that renewable energy source can meet partially the needs of developing countries in the forseable future, yet the basic features of choices for developing countries for the near future should include:

- Energy conservation.
- Diversification of energy sources.

Emphasis on the availability of a national or regional energy source should not be overlooked.

The role of high-income countries in the Third World will come at this stage. They can provide assistance and long term loans at low interest to low-income countries to enable them to invest in renewable energy resources. Industrial countries can provide the necessary experties and help in training the labour force of the less-developed countries.

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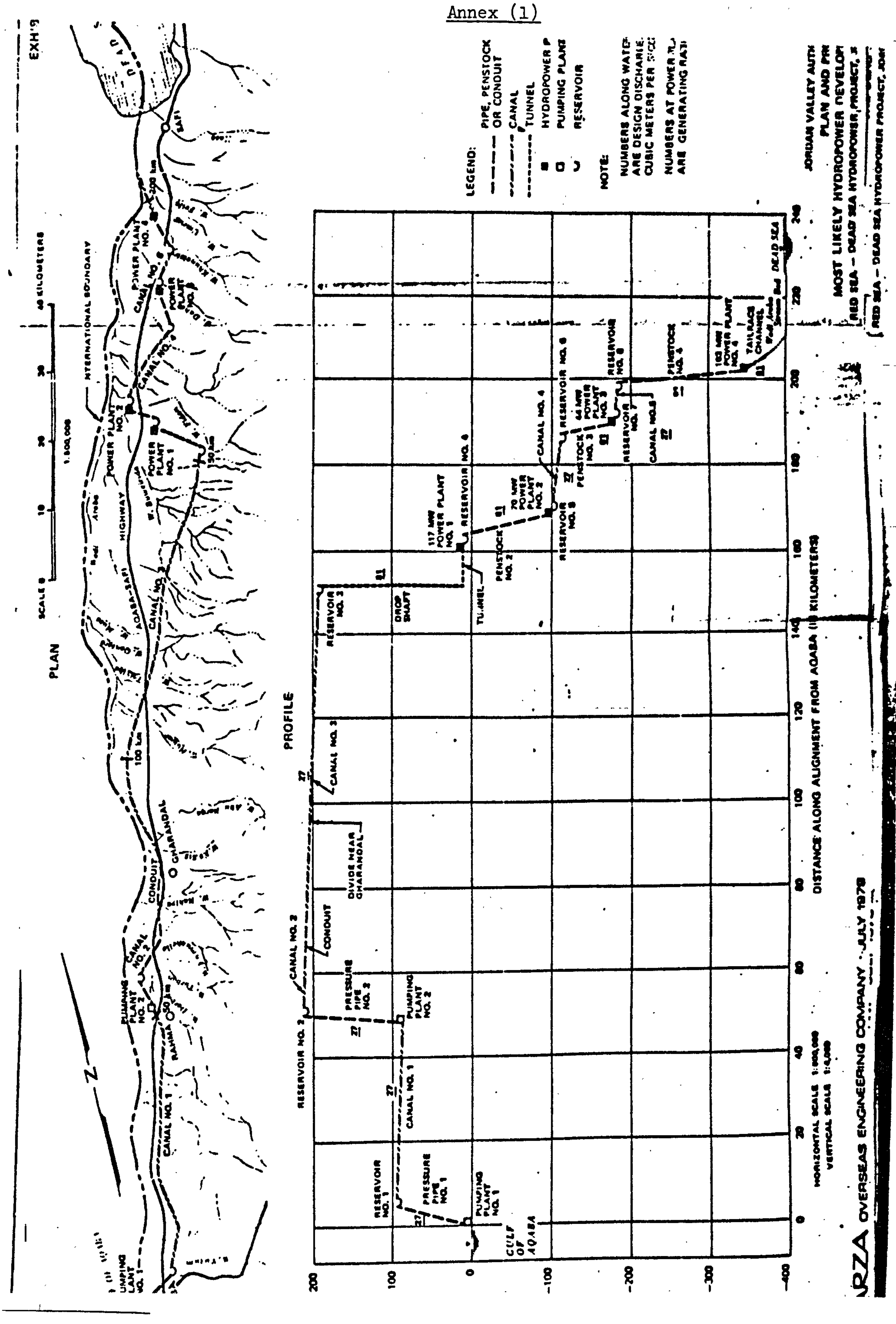
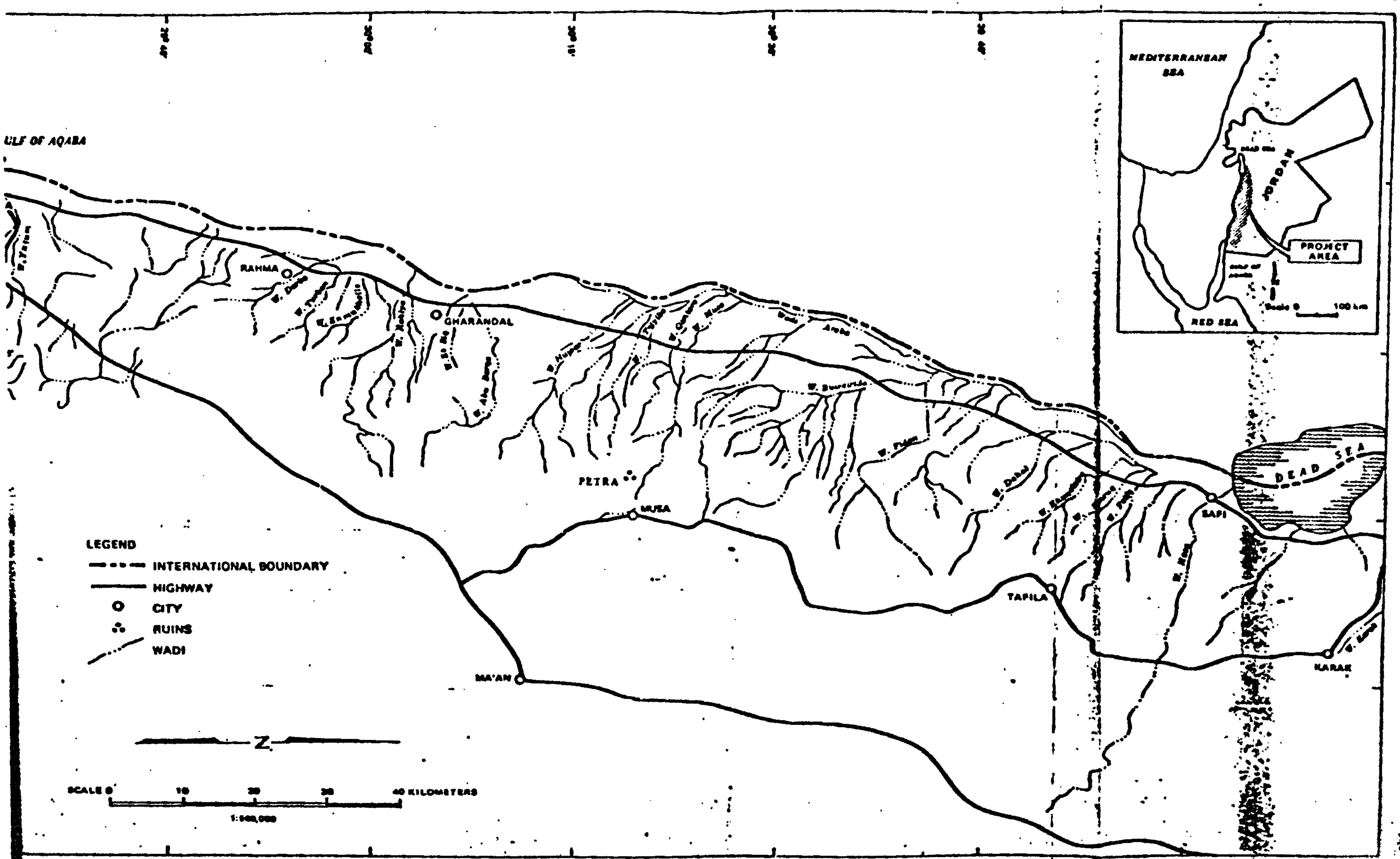
Annex (1)



PLAN
PROFILE
LEGEND:
PIPE, PENSTOCK OR CONDUIT
CANAL
TUNNEL
HYDROPOWER P
PUMPING PLANT
RESERVOIR
NOTE:
NUMBERS ALONG WATE
ARE DESIGN DISCHARGE
CUBIC METERS PER SEC
NUMBERS AT POWER PL
ARE GENERATING RATI
JORDAN VALLEY AUTH
PLAN AND PR
MOST LIKELY HYDROPOWER DEVELOP
RED SEA – DEAD SEA HYDROPOWER PROJECT
DISTANCE ALONG ALIGNMENT FROM AQABA (IN KILOMETERS)
HORIZONTAL SCALE 1:500,000
VERTICAL SCALE 1:4,000
HARZA OVERSEAS ENGINEERING COMPANY · JULY 1979
INTERNATIONAL BOUNDARY
HIGHWAY
AQABA-SAFI
SAFI
GHARANDAL
DEAD SEA
GULF OF AQABA
CANAL NO. 1
CANAL NO. 2
CANAL NO. 3
CANAL NO. 4
CANAL NO. 5
CANAL NO. 6
RESERVOIR NO. 1
RESERVOIR NO. 2
RESERVOIR NO. 3
RESERVOIR NO. 4
RESERVOIR NO. 5
RESERVOIR NO. 6
RESERVOIR NO. 7
RESERVOIR NO. 8
PUMPING PLANT NO. 1
PUMPING PLANT NO. 2
PRESSURE PIPE NO. 1
PRESSURE PIPE NO. 2
CONDUIT
DIVIDE NEAR GHARANDAL
DROP SHAFT
TUNNEL
PENSTOCK NO. 2
PENSTOCK NO. 3
PENSTOCK NO. 4
117 MW POWER PLANT NO. 1
70 MW POWER PLANT NO. 2
64 MW POWER PLANT NO. 3
152 MW POWER PLANT NO. 4
TAILRACE CHANNEL
EXH 9

EXHIBIT 1



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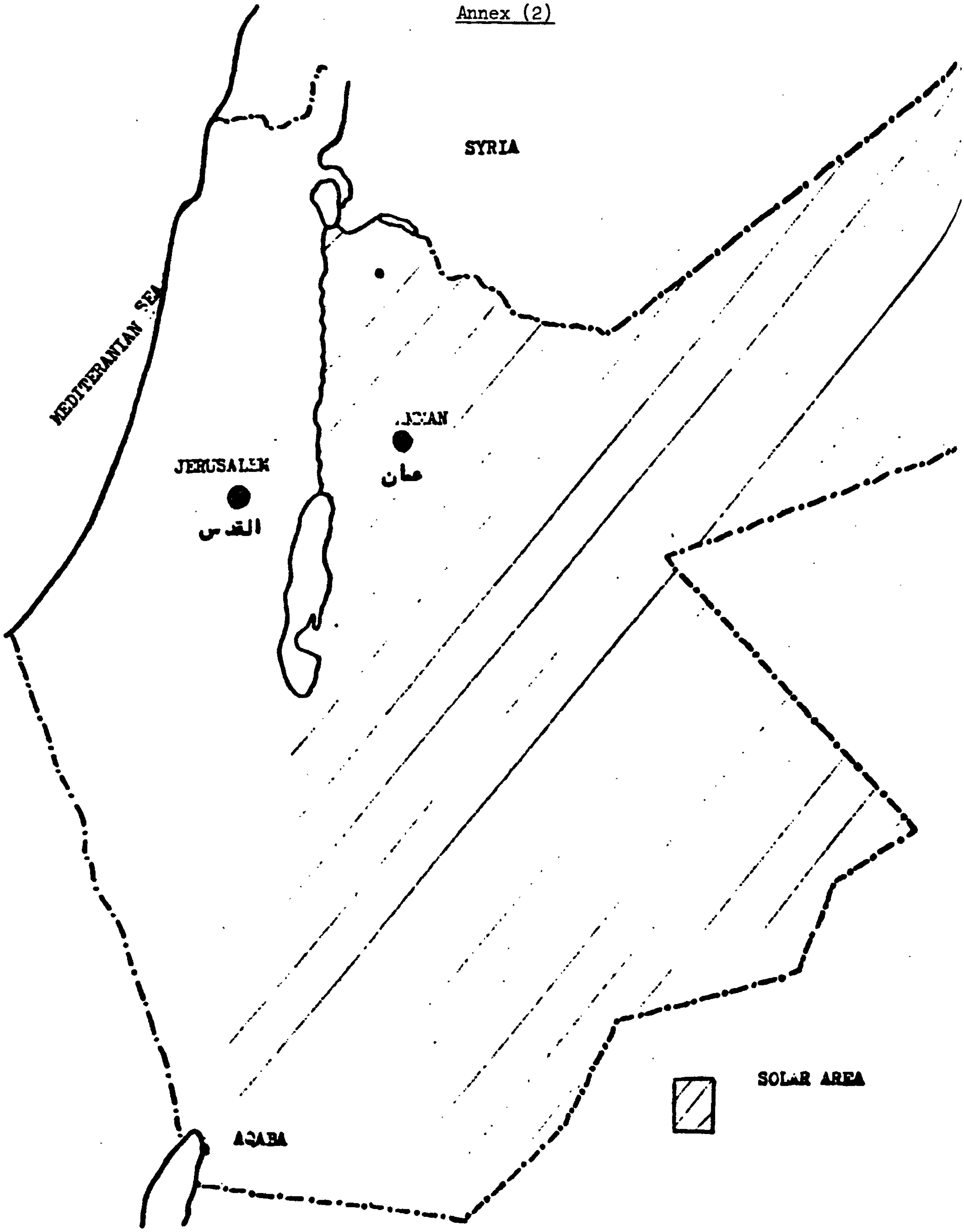
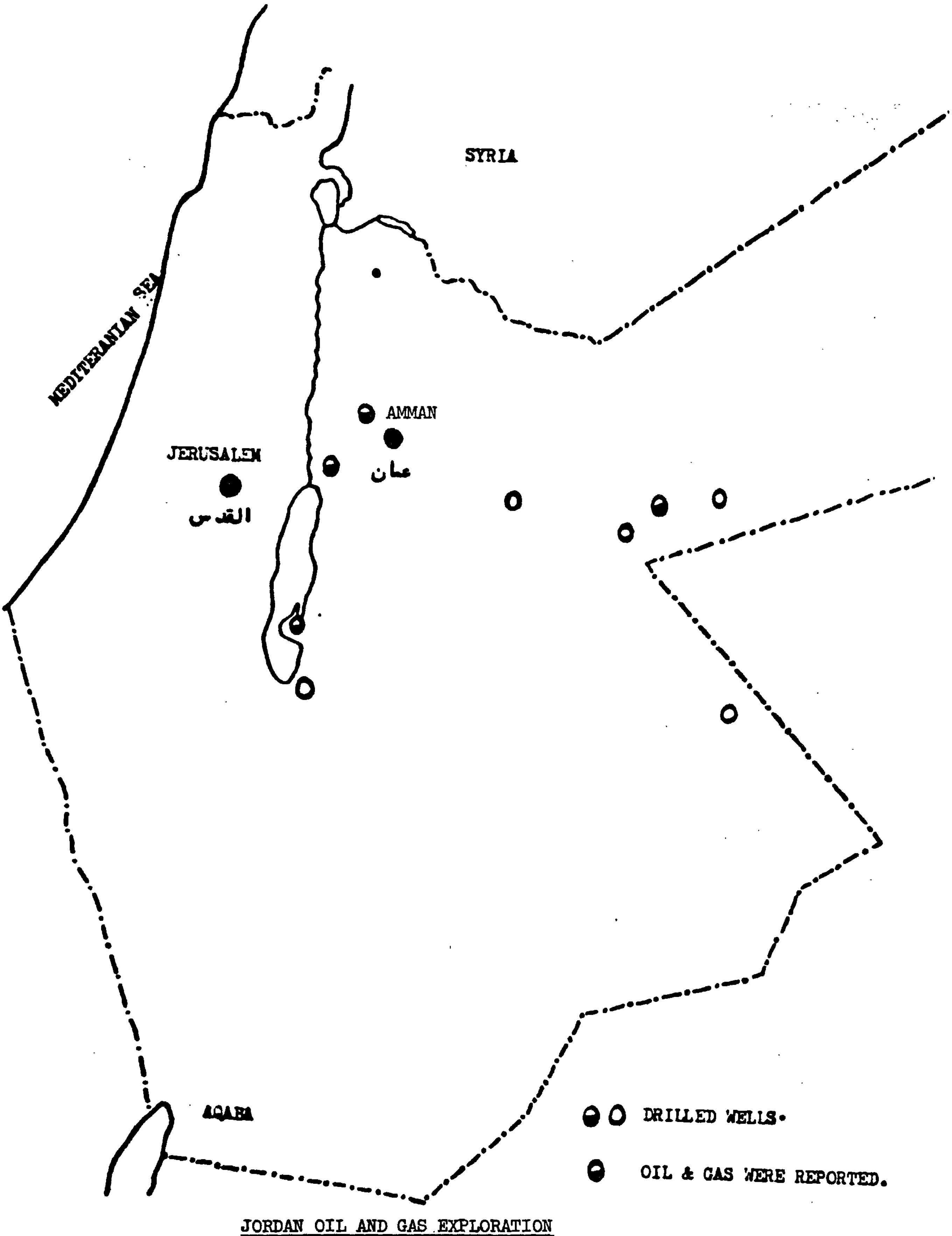
JORDAN VALLEY AUTHORITY
PROJECT AREA

Annex (2)

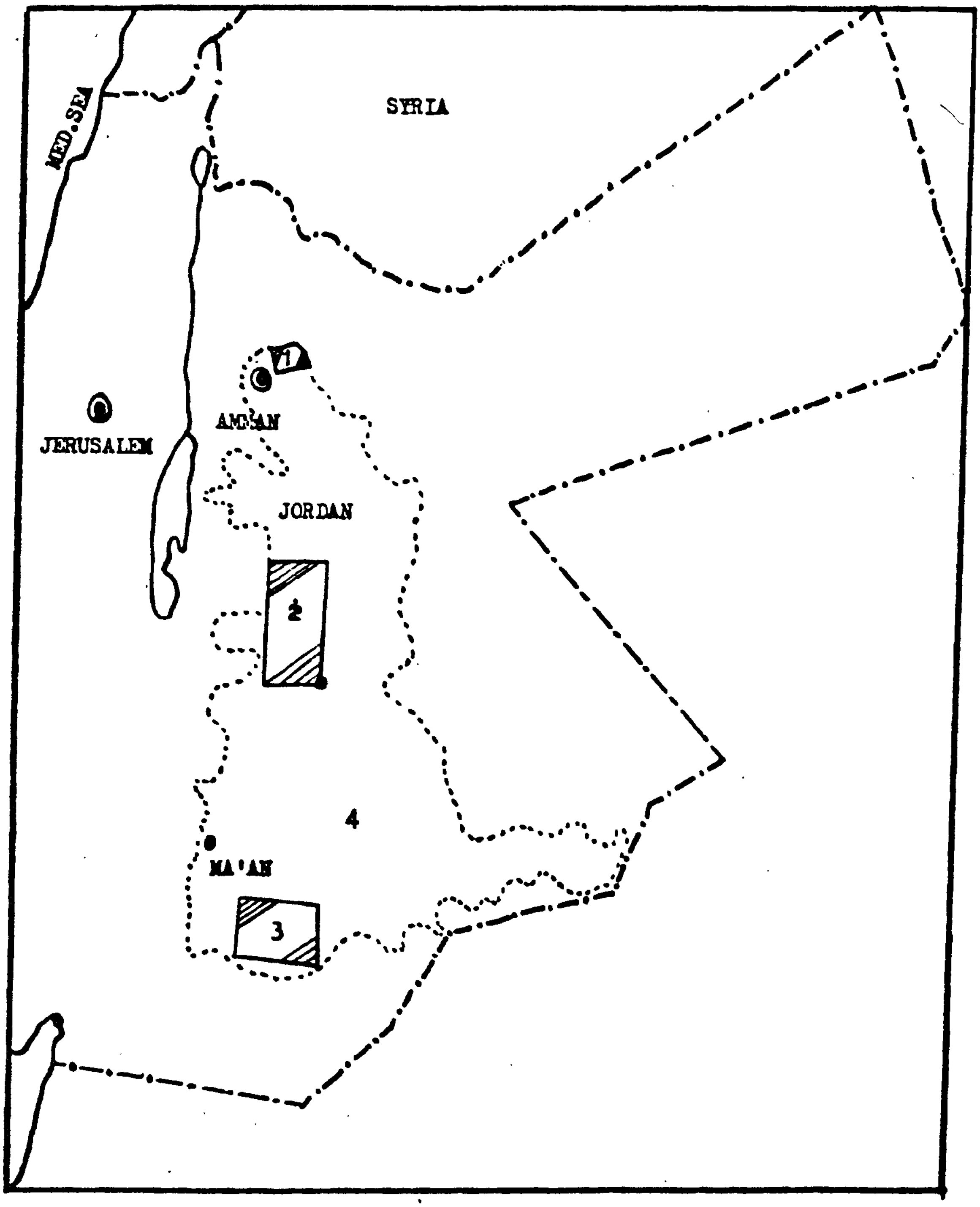


JORDAN SOLAR AREA



JORDAN OIL AND GAS EXPLORATION

JORDAN PHOSPHATE

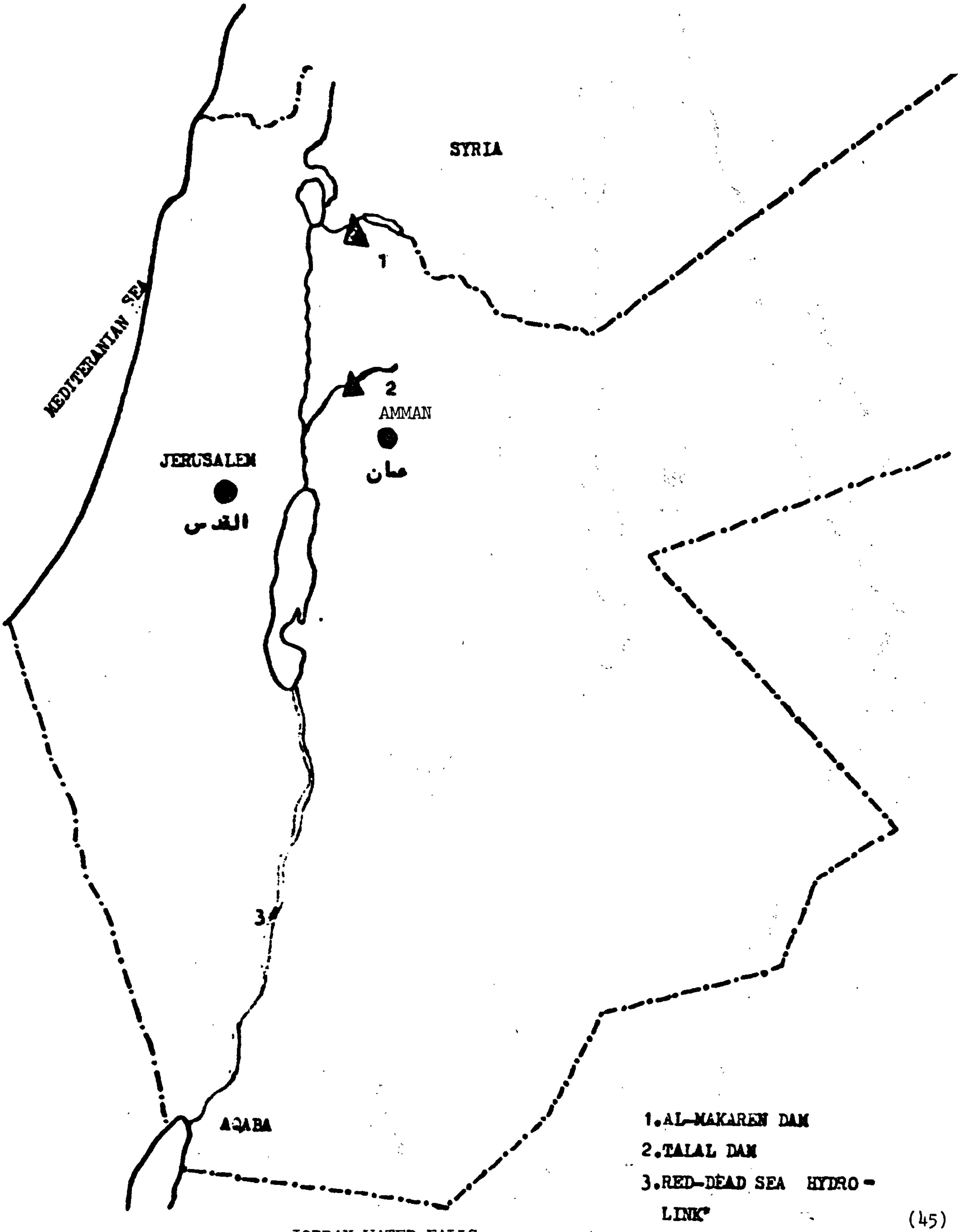


1 EXISTING PHOSPHATE MINING "DISTRICT OF RUSEIFA".

2 EXISTING PHOSPHATE MINING "DISTRICT OF ELHASSA".

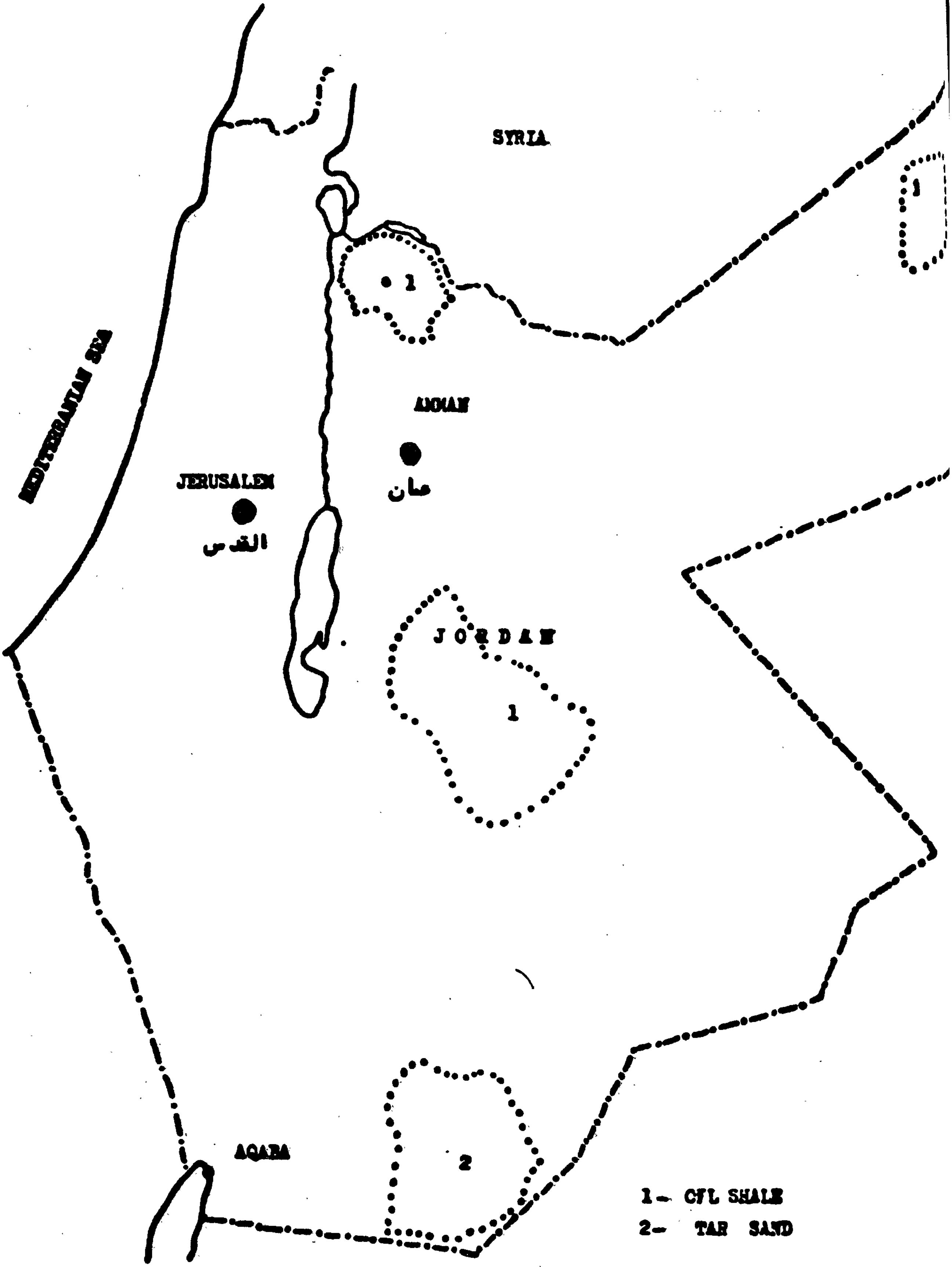
3 THE SHIDIYA DEPOSIT.

4 NEAR SURFACE PHOSPHATE.



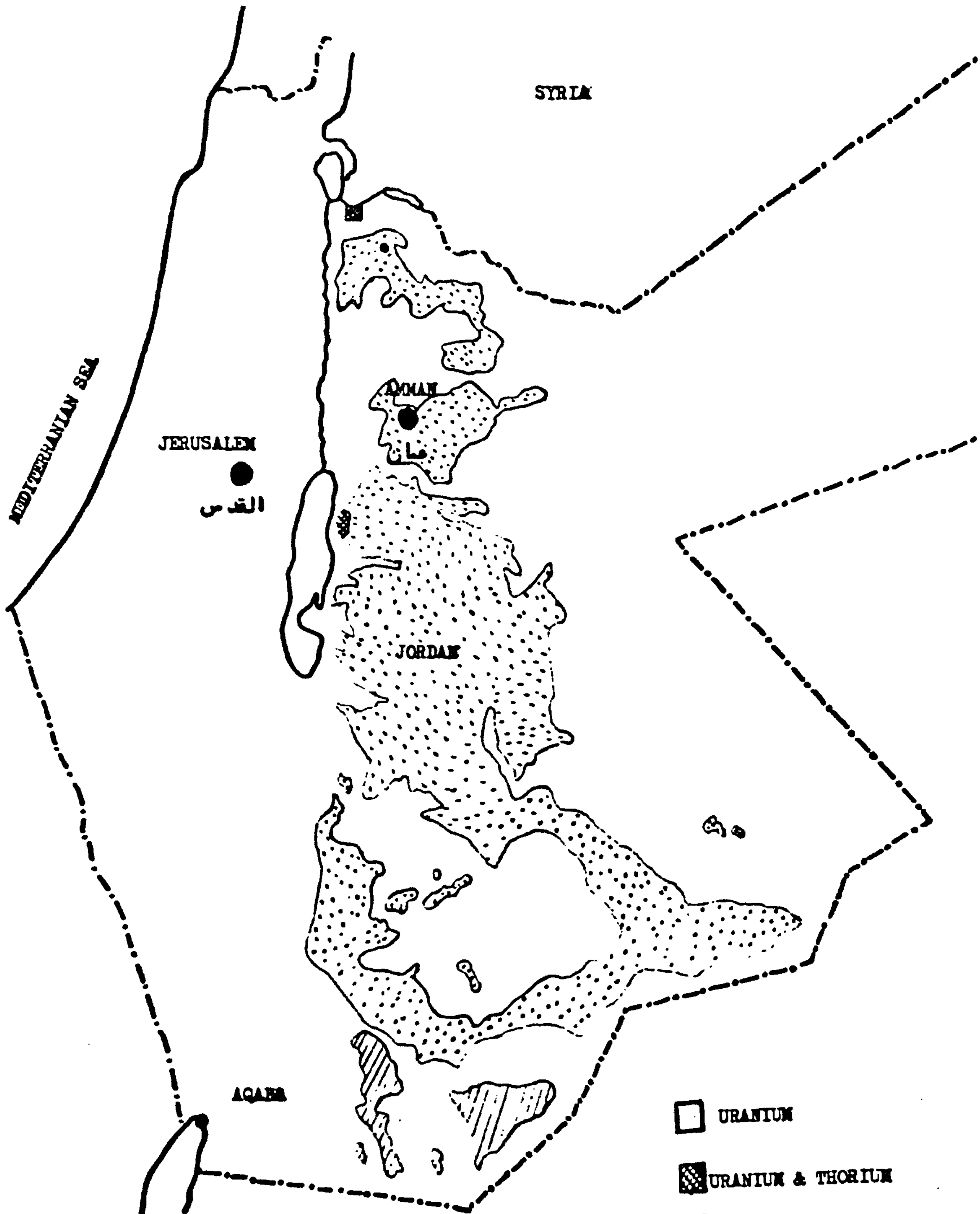
JORDAN WATER FALLS

1.AL-MAKAREN DAM
2.TALAL DAM
3.RED-DEAD SEA HYDRO-LINK



(46)

JORDAN OIL SHALE AND TAR SAND



JORDAN FISSILE FUEL